energies

Article

Environmental Efficiency of Enterprises: Trends, Strategy, Innovations

Mohammad Asif

Department of Finance, College of Administrative & Financial Science, Saudi Electronic University, Riyadh 13316, Saudi Arabia; masif@seu.edu.sa

Abstract: This study examines the impact of green process innovation (GPI), green entrepreneurial orientation (GPO), and proactive sustainable strategy (PSS) on environmental performance (EP). Data were collected from 294 Indian agriculture technology firms. Structural equation modeling (SEM) was used to analyze the data using Lisrel 8.80. This study aimed to analyze how green entrepreneurial orientation, sustainability strategies, and green process innovation improve the environmental performance of agricultural technology firms. The results show that green process innovation, sustainability strategy, and entrepreneurial orientation play a significant role in enhancing agricultural technology firms' environmental performance. Agricultural technology firms achieve high environmental performance primarily through strategy or sustainability. In every green process, innovation is crucial and essential. This research offers several practical implications that can be utilized by managers of agricultural technology firms to develop systems with cleaner production techniques in agribusiness. The novelty of the study lies in analyzing the direct relationships among green entrepreneurial orientation, strategy, and innovation in promoting the environmental performance of agricultural technology firms by drawing data from an agriculturally oriented developing country such as India.

Keywords: environmental performance; green entrepreneurial orientation; proactive sustainability; green economy; green strategy; Lisrel 8.80; SEM; green process innovation; agricultural technology firms

check for updates

Citation: Asif, M. Environmental Efficiency of Enterprises: Trends, Strategy, Innovations. *Energies* **2023**, *16*, 2683. https://doi.org/10.3390/en16062683

Academic Editors: Michal Cehlar and Sergey Zhironkin

Received: 1 February 2023
Revised: 5 March 2023
Accepted: 9 March 2023
Published: 13 March 2023

1. Introduction

The term agribusiness refers to "all the operations involving manufacturing and distribution of agricultural products" [1]. Agribusiness is a primary business and has a huge market, especially in India. With advancements in technology, the area of agricultural technology has witnessed huge development. With the inception of agricultural technology firms, economic growth occurred, as it depends on innovation and technological development [2,3]. Agricultural technology firms have now captured a healthy share of the market and are increasing their presence in various countries. The situation is no different in the Indian market.

As far as the procurement of agricultural raw material is concerned, India is considered one of the top producers of agricultural raw material, and agricultural business is an important and significant source of gross domestic product [4]. Agriculture technology (AgTech) firms usually combine technological and innovative capabilities and act as an important pillar in the development and growth of any economy. These agricultural technology firms have a rich research base, and with a blend of technology and innovation, these businesses have the potential to foster sustainable development [5]. These organizations have proposed many sustainable technological solutions in the agricultural sector [6]. With these solutions and business models, technological and innovative advances can be made in the area of agricultural technology [7]. Moreover, these agricultural technology firms can also provide and promote more sustainable systems [2,8]. However, these organizations also face some challenges from society and the local authorities [9].

In this context, achieving environmental performance is very important and a legitimate area of concern and research [10,11]. Therefore, in this study, antecedents of environmental performance were reviewed and researched. It is very well documented that one of the antecedents of organizational environmental performance is green process innovation (GPI). GPI includes innovative ideas for saving energy, recycling waste, and pollution control. However, research in this area is still ongoing, and the exact elements of green process innovation that affect environmental performance cannot be firmly determined. GPI refers to the adoption and implementation of technologies that reduce energy consumption in production processes. More specifically, GPI involves making a transition from conventional energy sources to bioenergy so as to reduce the total energy consumption and greenhouse emissions. GPI helps in combatting environmental problems, such as minimizing polluting discharges and air pollution by transitioning from conventional energy sources to bioenergy sources. Moreover, some studies have emphasized the antecedents of green innovation in external contexts [12,13].

Green entrepreneurial orientation (GPO) plays an important role in GPI, as it helps to implement green consciousness at the entrepreneurial level. Based on an integrated and comprehensive literature review, it was ascertained that there is a scarcity of studies linking the internal elements of green process innovation with environmental performance [14,15]. In addition to green process innovation, other antecedents, or the drivers of environmental performance, were also examined, such as green entrepreneurial orientation and proactive sustainable strategy [16]. It is important to study the relationships among green entrepreneurial orientation, sustainability strategies, and green process innovation to improve environmental performance in the context of agricultural technology firms. Although this topic has already been extensively studied, in the context of agricultural technology firms, which have a significant contribution in the agri-industrial sector, particularly in rural areas in a developing country such as India, there is a need for comprehensive research on the influence of green entrepreneurial orientation, sustainability strategy, and green process innovation on environmental performance.

Following this introduction, the paper is organized as follows. Section 2 discusses the material and methods, which broadly includes a literature review, the theoretical framework and hypothesis development, the contributions of the study, and its specific objectives and research methodology. The results in terms of the measurement model—structural equation modeling (SEM) assessment—are presented in Section 3. A discussion of the implications is presented in Section 4. Finally, the conclusion of the study, its limitations, and a direction for future work are given in the last section (Section 5).

2. Material and Methods

2.1. Literature Review

The literature in the field of agricultural technology suggests a strong role of green entrepreneurship for sustainable solutions in developing economies [5], which can only be possible through the utilization of cleaner processes, products, and technology for the production techniques in the process of commercialization [17]. In this context, green entrepreneurial orientation (GEO) is important. However, there is a scarcity of research in this area and its influence on environmental performance [15,18]. Although, the relationship between green entrepreneurial orientations and environmental performance is depicted in their study, ref. [11] noted that the influence of orientation on environmental performance is inconclusive and contradictory. As it is a contract-based relationship, inconsistencies cannot be ruled out [19]. Some studies have also highlighted some other antecedents, or the drivers of environmental performance [20,21]. The literature suggests that GEO alone cannot explain environmental performance completely. For example, refs. [22,23] have mentioned the importance of green supply chain management in explaining environmental performance. In addition, refs. [24,25] have highlighted green innovation in explaining environmental performance. From this perspective, we assume that green process innovation can help us more clearly understand the environmental performance of AgTech firms in India.

Proactive sustainable strategy is the core of environmental, social, and economic strategies [26,27]. A proactive sustainability strategy can be regarded as the initiating factor for all organizations to utilize resources efficiently, minimize waste, and safeguard the interest of stakeholders [28,29]. Although some researchers have pointed out inconsistencies in this relationship [30–32], there is strong evidence that proactive sustainability strategy influences sustainability [27]. This is relevant because in agricultural technology firms, their sustainability strategy is based on innovation [6]. In this regard, the role of their proactive sustainability strategy is important for achieving environmental performance.

2.2. Research Gap and Contribution of the Study

The researchers cited in Section 2.1 have facilitated curiosity in researching the influence of these variables on the environmental performance of agricultural technology firms in a developing economy such as India. It has been found that a very limited amount of literature is available on the influence of green process innovation, green entrepreneurial orientation, and sustainable strategy on the environmental performance of Indian AgTech firms. Therefore, this study was initiated to analyze the roles of entrepreneurship, strategy, and innovation through the measures of green entrepreneurial orientation, proactive sustainability strategy, and green process innovation, respectively, by regarding them as antecedents of environmental performance. The specific contributions of the study are as follows:

- Firstly, the assessment of sustainable practices in the context of AgTech firms has received very little research attention. So, this study aimed to address this knowledge gap;
- Secondly, while many studies have been conducted in Western countries, there is a dearth of research in Indian settings. Therefore, it is important to understand the dynamics of sustainable practices in this context of transforming Indian AgTech firms;
- Thirdly, the field is in its early stages, and much of the research in this field is based on literature reviews, secondary sources, and conceptual development, and the majority of studies in this field are theoretical investigations. Less research has been conducted on measuring these characteristics empirically and generalizing the results through quantitative analysis involving primary data collection sources;
- Lastly, the service sector has been studied a lot, but the agricultural sector has been looked at much less. Given the importance of the agriculture sector and sustainable practices, it is imperative to conduct a study to investigate the role of sustainable practices in enhancing environmental performance.

To examine these relationships, a sample of 294 agricultural technology firms was utilized, and the collected data were analyzed through structural equation modeling (SEM). This method is robust and has been very well documented in the area of agricultural technology firms in reputable studies [33]. The results of the research suggest strong relationships between the independent and dependent variables. During the data analysis, the measurement model and structural model were assessed and analyzed after testing the research scale for reliability and validity. Conceptual Framework of the Study is presented in Figure 1.

2.3. Theoretical Framework and Hypothesis Development

Innovation is regarded as an important construct responsible for the enhancement of performance. Technological innovation is especially useful for a sustainable competitive advantage [34]. The areas of green innovation and technological innovation play important roles in developing the economy to further the process of sustainability [35,36] and promoting green growth [37]. The sustainable innovations identified in the literature—regarded as antecedents of environmental performance—are important in this context as they also hamper the negative environmental impacts of organizations in their surroundings. The context is not different for agricultural technology firms as they operate on the basis of technology [8]. Specifically, green process innovation (GPI) includes energy saving, the prevention of pollution, and the recycling of waste [10].

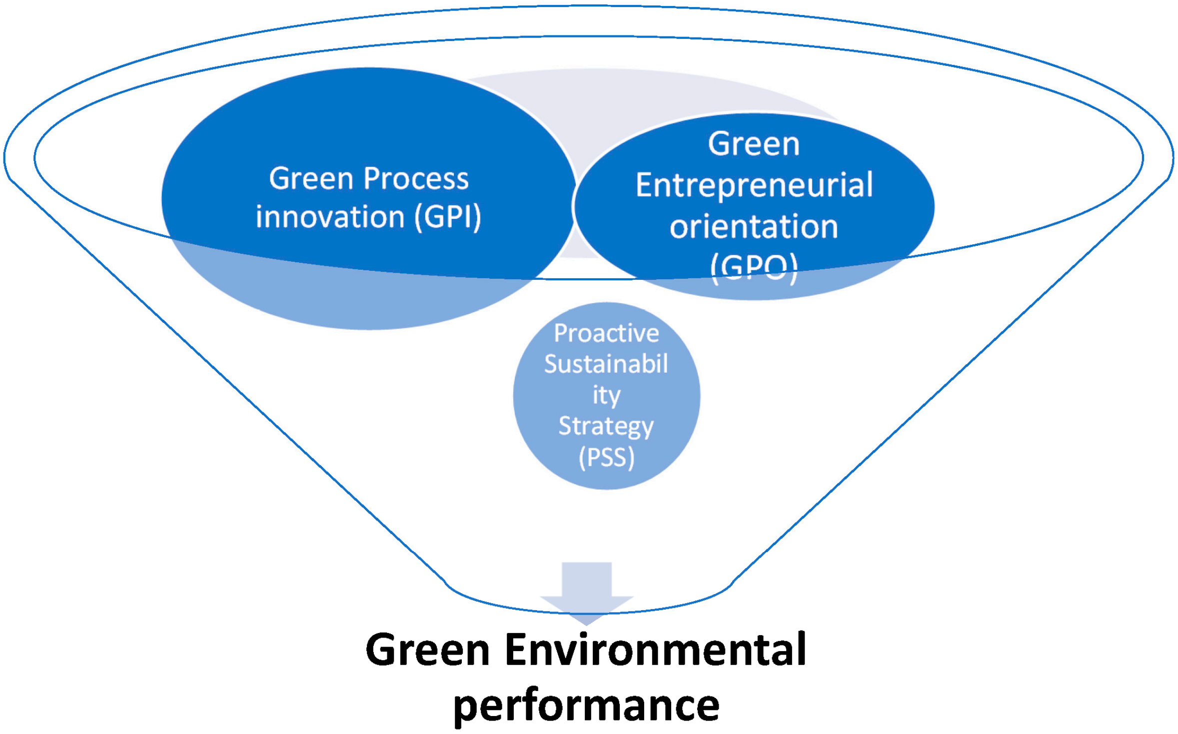

Figure 1. Conceptual Framework of the Study.

The relationships among the variables in the context of agricultural technology firms have been extensively studied and documented in the literature. However, there is still a need for further research to fully understand the potential and role of these firms in the development of sustainable agricultural practices. This is particularly relevant in the context of developing nations, where the transition towards sustainable agricultural practices is of paramount importance.

Innovation in the field of agricultural technology has the potential to foster a more sustainable environment by improving ecological processes and minimizing negative environmental impacts. The development of innovative water recycling methods and strategies for minimizing pollution are particularly important in this regard. These efforts not only improve the environmental performance of agricultural technology firms but also serve as a means of legitimizing their activities in the eyes of society and addressing regulatory pressure from local authorities. This is supported by previous research, as cited in references [9,10,23,33,38,39]. These activities are not new for agricultural technology firms as they are busy creating more sustainable solutions through innovations. This green process innovation is very crucial for organizations for both (1) minimizing waste and energy in production and (2) minimizing the cost and penalties from authorities and local bodies [23,39].

Many previous studies have pointed towards green process innovation's relationship with environmental performance in agricultural technology firms [10,25,39]. However, agricultural technology firms, in their very nature, are conservative, which acts as a barrier to certain innovations. However, agricultural technology firms are a result of technological evolution, and they substantially raise the standards in the area of technology and innovation in agribusiness [3,40]. Sustainability transformation includes technological upgradation guided towards efficient processes [35] and complying with environmental standards for agricultural technology firms [9]. Therefore, the following is hypothesized:

H1. *Green process innovation (GPI) influences environmental performance (EP) positively.*

Entrepreneurial orientation refers to searching for innovations and potential opportunities and minimizing risk for better performance of a firm [11,21]. All of these elements have been found to be present in green entrepreneurial orientation. Agricultural technology firms try, through their activities, to facilitate environmental benefits. However, authors have concluded that the relationship is yet to be tested in different contextual settings, and only then can the results be generalized [19]. In this context, the literature is more relevant, as it was observed by [41] that in many new agricultural technology firms, the actions of the founders/entrepreneurs of these technology firms are based on their orientation and experiences from their previous companies. Therefore, the role of entrepreneurial orientation cannot be neglected in the assessment of the environmental performance of agricultural technology firms.

This positive and direct relationship between these variables has not been examined in the context of agricultural technology firms until now. Although the role of environmental orientation on many mediating and moderating variables has been assessed in many studies, the insights from the recent literature, especially in the context of agricultural technology firms, confirm the relationship. In addition, AgTechs are organizations that often participate in innovation ecosystems, have active contacts with educational and research institutions, and are constantly seeking funding to drive business growth [37]. All of this reveals an unknown environment for analyzing the role of entrepreneurial orientation in environmental performance. The green entrepreneurial orientation of organizations improves the efficiency of processes, encouraging new ideas and innovations and minimizing waste [42]. Therefore, due to the literary relevance of the constructs and their scope, it is assumed that green entrepreneurial orientation in these organizations impacts the efficiency of processes and emphasizes minimizing waste [43,44]. Therefore, it is proposed that:

H2. *Green entrepreneurial orientation (GPO) influences environmental performance (EP) positively.*

It is also well documented in the literature that a proactive sustainability strategy also promotes activities pertaining to environmental and social characteristics. Environmental strategies designed in an organization are aimed at preserving resources, whereas economic strategies focus on equally treating each member of the society in terms of providing them with opportunities [26,32]. The interconnectedness of these strategies to obtain a sustainable advantage is presented in the literature [45]. Proactive sustainability strategies are responsible for forecasting demands and also play an important role in making organizations stand up to those demands [46].

This relationship is positive, as suggested by [30]. Some authors criticized this notion, as they concluded there is a mix of relationships among these variables [31]. After taking into account these conflicting findings, it was necessary to examine this relationship in the context of agricultural technology firms in the latest technology-oriented environment in an Indian context. Secondly, as has been made evident in many studies, proactive sustainability strategies have a relationship with sustainable corporate performance.

Agricultural technology firms are able to promote PSS thinking about environmental sustainability. This alignment between strategy and innovation is essential for startups to achieve their organizational goals [47], such as sustainable outputs in the case of AgTech firms. Thus, it seems plausible to assume that proactive sustainability strategy and environmental performance have a strong relationship.

However, there is a scarcity of research on how elements influence corporate performance, as they have not been included in most studies [27,33]. Therefore, it is suggested that proactive sustainability strategies should include environmental, economic, and social strategies so that they can reduce pollution, the consumption of energy and materials, and possible environmental accidents by improving the proper consumption of resources and facilitation by reducing waste [46,48]. Therefore, it can be proposed that:

H3. *Proactive sustainability strategy (PSS) influences environmental performance (EP) positively.*

2.4. Research Methodology

2.4.1. Sampling Strategy

The sampling frame for the study was derived from the ranking of the Top 1000 companies in India published in *Business Standard* (2022) (*Business Standard*, India's leading business newspaper, provides the latest news on stock markets, investing, companies, industry, banking, finance, and economy. It is an independent research house that annually publishes the rankings of companies in India). The sample frame was obtained in two steps:

Step 1. The *Business Standard*'s ranking of the Top 1000 Companies in India served as the initial sample frame. The above list of the top-ranking companies contained both Indian and foreign companies operating in India. From the above list, the Indian companies were shortlisted. Specifically, from the list of 1000 companies published in *Business Standard*, 946 Indian companies were identified. These companies were verified through the BSE website of their country of origin (BSE Ltd. was the first-ever stock exchange in Asia; it was established in 1875 and was the first in the country to be granted permanent recognition under the Securities Contract Regulation Act, 1956, and it has had an interesting rise to prominence over the past 137 years). The website mentions the country of origin/ country of headquarters for each company listed.

Step 2. From the above 946 shortlisted Indian companies, the list was further narrowed down to include only those companies that have some form of agriculture-related operations. This was necessary since the study was focused on agricultural technology firms. Finally, 294 companies were selected for data collection.

The top-ranking companies were considered in the present study following other researchers in the area. Since these are top-ranked organizations, they are expected to have well-established departments. Taking such high-performing organizations, the researchers assumed that proper systems and clear roles existed within them.

Convenience sampling was used in this study. Responses were obtained from senior-level managers of the top-ranking companies. Senior executives have also been used as respondents in other similar studies [49,50]. Senior managers were regarded as the "subject matter experts" and believed to be in a good position to provide the required information [51]. Jones (1996) studied the perceptions of senior practitioners since they have direct responsibility for strategic issues [52].

2.4.2. Survey Instrument

Data were obtained from a structured questionnaire, which had two parts. The first part was related to the firms' profiles, while the second part addressed items that measured their proactive sustainability strategy (PSS), green process innovation (GPI), green entrepreneurial orientation (GPO), and environmental performance (EP). We used five items to gauge the entrepreneurial orientation of the agricultural technology firms. Examples of such statements include "in dealing with competitors, we often launch green initiatives that competitors respond to" and "in general, our firm favors a significant emphasis on green practices, such as R&D, technological leadership, and innovation".

The proactive sustainability strategy measurement, which was derived from environmental strategy (four items), economic strategy (three items), and social strategy, was taken from [27]. For instance, the environmental strategy item "supporting sustainable resources management" (e.g., renewable energy) and the economic strategy item "creating sustainability business practices" measure the development of human capital (social strategy). According to [10], "green process innovation" consists of four components that are rated from never (1) to always (5). "Low energy consumption such as water, electricity, gas, and petrol during production, usage, and disposal" and "Use of cleaner technologies to make savings and prevent pollution" are examples of actions in the production process. Environmental performance was the final dependent construct, and it was taken from [11]. It has four components, ranging from totally disagree (1) to totally agree (5). "Reduced energy and materials consumption" and "Reduced consumption of hazardous/harmful/toxic materials" are a couple of examples. Construct are adopted from various studies as presented in Table 1.

Table 1. Summary of Research Constructs.

Research Constructs	Items	Authors
GPI	09	Huang and Li, (2017) [10]
GPO	08	Jiang et al. (2018) [11]
PSS	09	Wijethilake (2017) [27]
EP	08	Jiang et al. (2018) [11]

2.4.3. Assessment of Response Bias

A research sample consisting of 605 Indian agricultural firms was chosen. Invitations were sent with the research questionnaire from the period of January to March 2022. A total of 300 responses were obtained from various agricultural technology firms, for a response rate of 49.58 % of the initial sample. As 6 responses were incomplete, the final tally was 294 usable questionnaires. Response and non-response biases were determined. Response bias was tested by performing exploratory factor analysis (EFA) and non-response bias was ruled out by a comparison of the initial and late respondents, as the number of late respondents was similar to the non-respondents [53].

The scale was measured on a Likert scale from strongly agree to disagree. Green entrepreneurial orientation was measured through items adapted from [11]. Likewise, the proactive sustainable strategy scale was adopted from [27]; this scale comprised 9 items. Similarly, the green process innovation scale was taken from Huang and Li (2017); it had 8 items and was measured on a 5-point Likert scale [10]. Dependent variable environmental performance (EP) was extracted from [11]; the scale comprised 8 items and was measured on a 5-point Likert scale.

During the data analysis, efforts were made to minimize common method bias (CMB). This error can be found in many studies in which data are collected from a single source or when data are collected using self-administered questionnaires. Therefore, a cover letter was prepared, guaranteeing the secrecy of identities and confidentiality of the responses. Ambiguous statements were avoided, and different color schemes were used so that the respondents could differentiate among the different constructs. Proper labeling of the constructs was also undertaken in this manner, and a simple research instrument was developed to minimize CMB [54]. Estimation of non-response bias is given in Table 2.

Table 2. Group statistics for estimation of non-response bias.

	TMS5	N	Mean	Std. Deviation	Std. Error Mean
GPI	Ely	262	2.5255	1.32550	0.22473
	Lte	32	2.0245	1.32469	0.22510
GPO	Ely	262	1.8236	1.32560	0.22902
	Lte	32	1.2281	1.12451	0.22197
PSS	Ely	262	1.6264	1.39882	0.22823
	Lte	32	1.7297	1.48758	0.22718
EP	Ely	262	2.7273	1.75070	0.32325
	Lte	32	2.7219	1.62233	0.22318
Component Transformation Matrix					

2.4.4. Descriptive Statistics

The respondents' and responding firms' profiles are shown in Table 3.

Table 3. Descriptive analysis.

Demographic Variables	Frequency	Percent
Designation		
Sr. Manager	157	53.4
VP	110	37.41
CEO	27	9.18
Total	294	100.0
Experience (Present position)		
More than 15 years	168	57.14
More than 6 years	126	42.85
Total	294	100.0
Total Experience		
0–20 years	147	50.0
>21 years	147	50.0
Total	294	100.0
Size of the firm		
0–1000 Employees	156	53.0
1000–2500	109	37.0
More than 2500	29	10.0
Total	294	100.0
Sector		
Public	167	57.0
Pvt.	127	43.0
Total	294	100.0

The measurement validity was also assessed, and efforts were made to orient the respondents on the research instrument. The reason for the selection of the respondents was also made clear to all the respondents, and risks for participation and attached advantages were also presented [55].

2.4.5. Data Analysis Techniques

When the analysis was performed using SEM, initially, the measurement model was assessed. In the process of the assessment of the measurement model, various tests were performed. This started with determining the unidimensionality, reliability, and validity, which refers to the methodology employed in conducting a structural equation modeling (SEM) analysis. SEM is a statistical technique that can be used to test complex hypotheses about relationships among multiple variables. When performing SEM analysis, it is important to first assess the measurement model, which is a model of how the variables are measured.

This study employed SEM using Lisrel 8.80. (software for analyzing primary data collected for study scales). This technique is robust for complex modeling that involves more than two independent variables and for not so large a sample size [56]. The sample size adequacy was ascertained through two methods. The first method is advocated for by the developers of Lisrel 8.80, Joreskog and Sorbom (1993), using the formula given as follows [57]:

$$k\,(k-1)/2$$

where the number of variables = k, (k) = 4, the minimum sample size is 6, and the sample size of 294 cases is adequate. Secondly, with an effect size of 0.10, an error probability of 0.05, and a total sample size of 294, the number of items predicting the dependent variable is 3. The sample power calculated was more than 80%, meeting the requirement to confirm that the modeling can easily be carried out [58].

3. Results

3.1. Assessment of Measurement Model

In the process of assessing the measurement model, various tests were performed to ensure that the model was appropriate for the data. One of the first tests that is typically conducted is the assessment of unidimensionality. Unidimensionality refers to the idea that the variables being measured should all be measuring the same underlying construct or concept. In other words, the variables should be related to each other in a consistent way. To assess the unidimensionality, factor analysis or parallel analysis is often used.

Another test that is typically performed when assessing the measurement model is an assessment of the reliability and validity. Reliability refers to the consistency of the measurements and is typically assessed by examining the internal consistency of the variables, such as Cronbach's alpha. Validity, on the other hand, refers to the extent to which the variables are actually measuring what they are supposed to. To assess the validity, various methods, such as the content validity, criterion-related validity, and construct validity, can be used.

It is worth noting that SEM is a powerful method, but it also has some limitations. For example, it assumes normality of the data, and also assumes that the measurement errors are independent. Therefore, it is important to carefully evaluate the assumptions of the model and also to ensure that the data meet the requirements of the method.

When CFA was performed for all the research variables, green entrepreneurial orientation was not found to be unidimensional, and therefore, one item of this construct was excluded to obtain a refined scale (Figure 2). The results are as follows: The path value for all the research constructs was found to be more than 0.50. The internal consistency was ensured by Cronbach's alpha, and the value of the alpha for all of the research constructs was more than the minimum standard of 0.70, and the maximum value was 0.95 [56]. The AVE was 0.60 (Table 4), which is greater than the acceptable threshold of 0.50. In this manner, all scales were pretested, which refers to the process of conducting a confirmatory factor analysis (CFA) for the research variables and the results obtained.

Table 4. Cronbach 's alpha, CR, and VE.

Scale	Cronbach's Alpha	Constructs Reliability (CR)	Variance Extracted (VE)
GPI	0.764	0.7	0.7
GPO	0.831	0.7	0.6
PSS	0.748	0.7	0.6
EP	0.832	0.6	0.7

CFA is a statistical technique used to test the measurement model of a set of variables. In this context, the research variables analyzed included the construct of green entrepreneurial orientation. However, when the CFA was performed, it was found that this construct was not unidimensional, meaning that the items included in the scale did not all measure the same underlying construct or concept. Therefore, to obtain a refined scale, one item of this construct was excluded. The results of the CFA are presented in Figure 2 and Table 4, which indicate that the path value for all the research constructs was greater than 0.50.

Internal consistency, a measure of how well the items in a scale are related to each other, was ensured by using Cronbach's alpha, a commonly used measure of internal consistency. The results show that the alpha values for all of the research constructs were greater than the minimum standard of 0.70, with a maximum value of 0.95. Additionally, the average variance extracted (AVE) was 0.60, which is greater than the acceptable threshold of 0.50. This indicates that the pretested scales were found to be reliable and valid for use in the research.

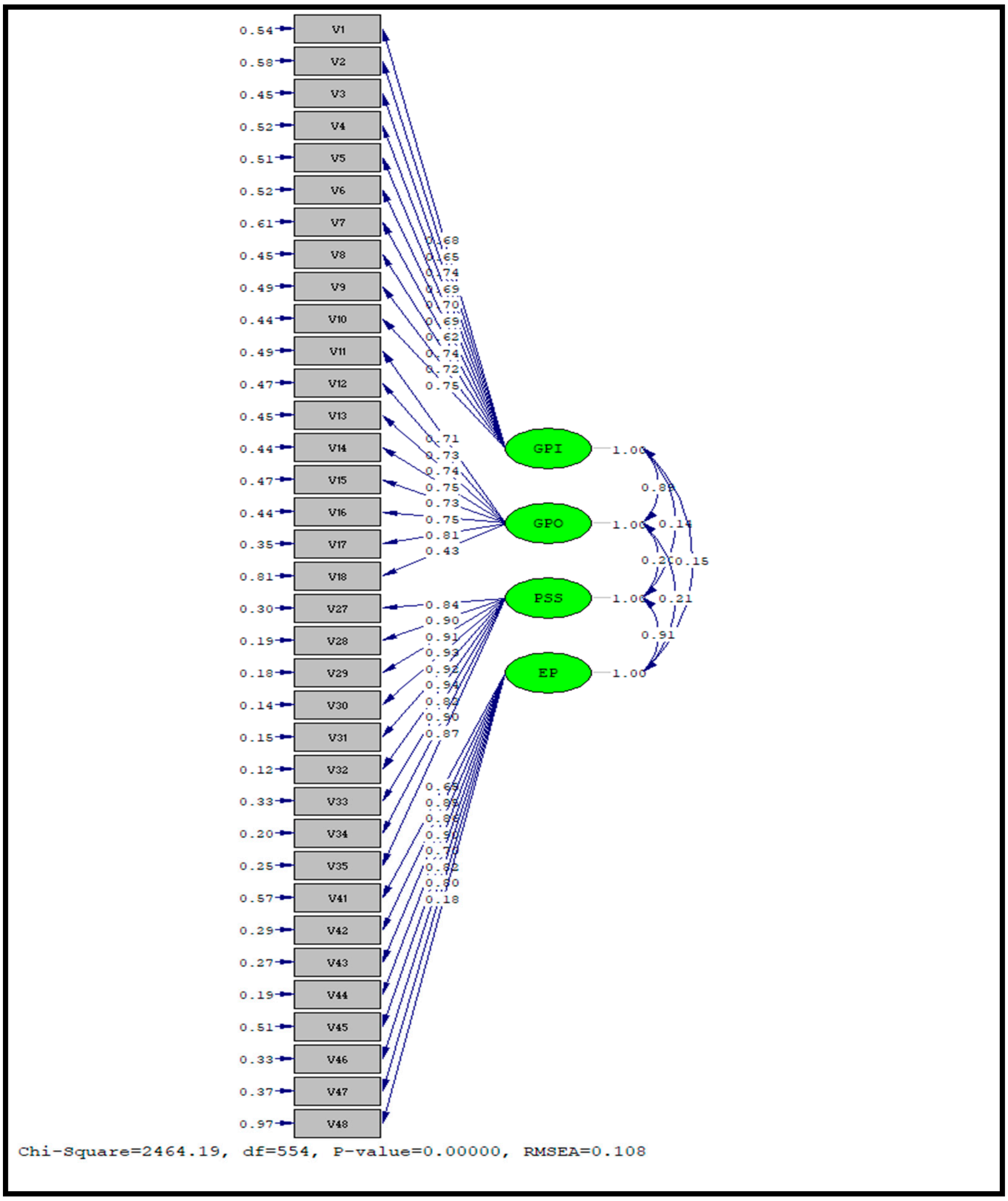

Figure 2. Confirmatory Factor Analysis.

In this manner, common method bias was also ruled out [54]. Convergent validity was established through the path values, t-values, and normalized fit index (NFI) values. All of the values were within the acceptable ranges (Tables 5 and 6).

Table 5. Showing fit indices and t-values.

Scale	Loading Value Range	NFI	Range of t-Values
GPI	0.50–0.87	0.89	4.56–15.70
GPO	0.56–0.85	0.91	4.75–16.83
PSS	0.72–0.95	0.91	10.64–12.26
EP	0.64–0.77	0.92	8.26–12.56

Table 6. Correlation values indicating discriminant validity.

Scale	GPI	GPO	PSS	EP
GPI	1.000			
GPO	0.370	1.000		
PSS	0.342	0.054	1.000	
EP	0.275	0.032	0.011	1.000

3.2. Structural Equation Modeling (SEM) Assessment

A structural equation modeling (SEM) assessment was carried out, the hypotheses were tested, and based on the estimates provided by Lisrel 8.80, the results were interpreted. Hypothesis 1, which proposed that green process innovation (GPI) influences environmental performance (EP) positively, is supported, as the estimated value is significant (B = 0.02, p value < 0.005). Similarly, hypothesis 2, which proposed that green entrepreneurship orientation (GPO) influences environmental performance (EP) positively, is also supported, as the estimated value is significant (B = 0.01 p value < 0.005). Finally, H3, which proposed that proactive sustainability strategy (PSS) influences environmental performance (EP) positively, is also supported, as the estimated value is significant (B = 0.91, p value < 0.005) (Figure 3 and Table 7).

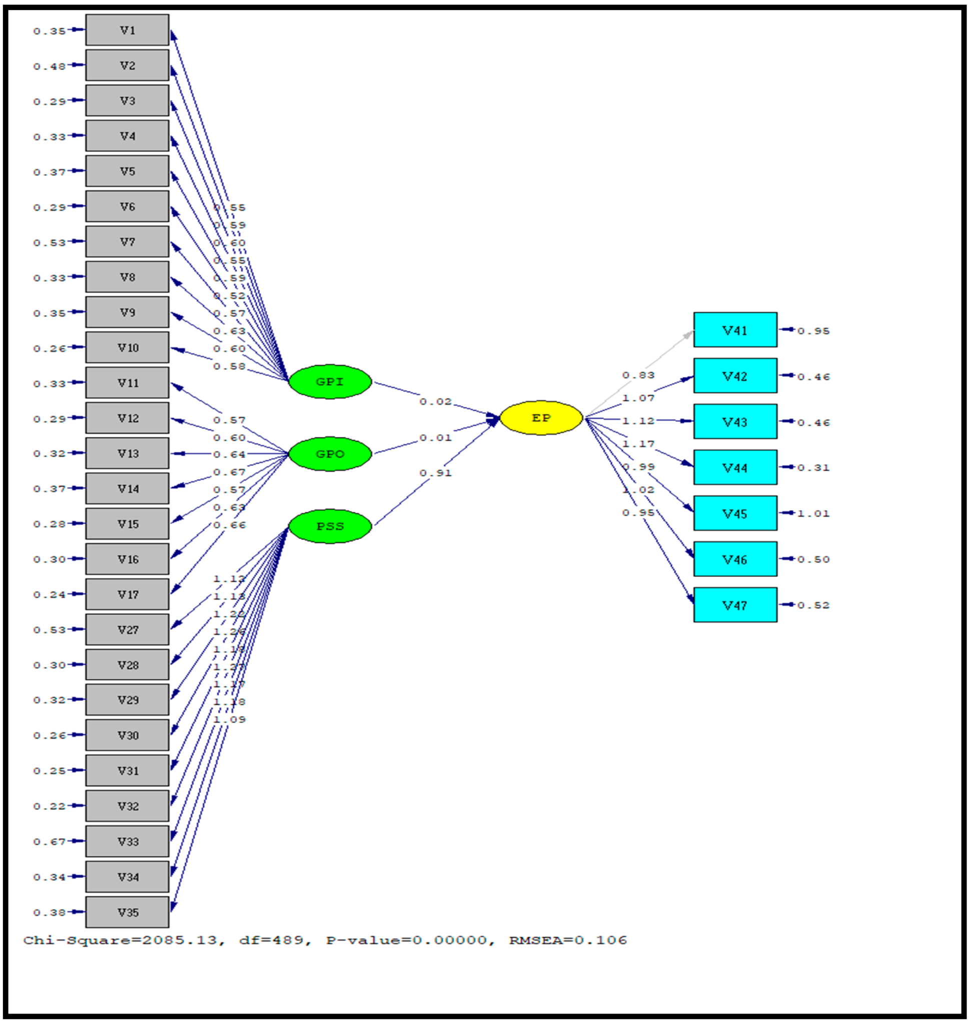

Figure 3. SEM Results.

Table 7. Results of hypothesis testing.

Hypothesis No.	Estimate	*p* Value	Result
1.	B = 0.02	<0.005	Accepted
2.	B = 0.01	<0.005	Accepted
3.	B = 0.91	<0.005	Accepted

The fit indices were found to be within the acceptable ranges and are given in Table 8.

Table 8. Fit Indices.

Constructs	Fit Indices						
	GFI	AGFI	NFI	NNFI	CFI	SRMR	RMSEA
Model	0.95	0.89	0.87	0.83	0.88	0.06	0.11

4. Discussion and Implications

This study was intended to explore the effects of (GPI), (GPO), and (PSS) on EP. The contents of this research included agricultural technology for the Indian ecosystem, which is regarded as a developing economy. The hypotheses were formed from the latest literature and tested using structural equation modeling (SEM). Three interesting findings and their implications are discussed here.

Firstly, we found support for hypothesis 1 that green process innovation positively influences environmental performance. This indicates that GPI promotes environmental performance. This finding is also supported by the results of [10,23]. However, this relationship in the context of agricultural technology firms needs to be researched, as agricultural technology firms have great potential in developing methodologies. Due to transitions in developing nations, innovation fosters a more sustainable environment by improving ecological-oriented processes, which minimizes negative environmental effects [30,35]. Innovative water recycling methods and steps toward the minimization of pollution appear to be the most appropriate antecedents of an agricultural technology firm's environmental performance. This also helps in legitimizing their activities to society and in facing regulatory pressure from local authorities [9,10,23,39].

In hypothesis 2, it was proposed that green entrepreneurial orientation (GPO) influences environmental performance (EP) positively. The results statistically support this hypothesis, and hence, this hypothesis is accepted, which means that GPO increases EP. This finding is consistent with those of previous studies [59,60], but it is not free from exceptions [61]. However, it is important to note that the previous literature in this area suggests that the nature of this relationship may vary depending on the specific operations of the firms under examination [62].

Despite this potential variation, the findings of this study can be easily generalized to a larger population due to several reasons. Firstly, the sample of respondents in this study was composed of individuals with a high degree of experience in the field of agricultural technology, as evidenced by the fact that most of the respondents had long-term experience in the industry. This suggests that the sample is representative of the population of interest and that the results of the study can be extrapolated to other similar firms. Additionally, the sample size was large enough to provide a high level of statistical power and generalizability.

Secondly, it has been well established in the literature that a significant proportion of agricultural technology businesses have a close relationship with higher education and research institutions. These institutions serve as a major source of entrepreneurial talent for these firms, with many entrepreneurs coming from these institutions with the skills, knowledge, and network necessary for success [62].

Thirdly, the findings provide support for the third hypothesized relationship between sustainable strategy and environmental performance, indicating that sustainable strategy increases the likelihood of environmental performance. This finding is also aligned with the existing literature [63,64]. The entrepreneurs that are attracted to the agricultural technology sector tend to possess a unique entrepreneurial profile, characterized by a "green conscience" or a strong commitment to environmental care [11]. This mindset and commitment further facilitate the environmental performance of these businesses, as they are more likely to implement sustainable practices and develop innovative solutions that address environmental issues. This is supported by research showing that firms with environmentally oriented entrepreneurs tend to have better environmental performance [11,64]. This highlights the importance of the role of entrepreneurs in driving sustainable practices in agricultural technology businesses. The coordination of strategy, innovation, and organizational goals is a constant struggle for agricultural technology firms. In such contextual settings, these relationships are very important. This finding is in line with those of [27,62].

This study has several theoretical implications. Firstly, the results confirm the notion that entrepreneurship can provide a solution for environmental problems by identifying the relationship between green entrepreneurial orientation and environmental performance. This research contributes to the field by exploring the antecedents of environmental performance in the agricultural technology sector [15]. Secondly, this research contributes to the literature by linking the internal antecedents of green performance within agricultural technology firms. Specifically, it suggests that innovative water recycling methods and steps for minimizing pollution are important antecedents of the environmental performance of these firms. Thirdly, it highlights the important role of agricultural technology firms in fostering sustainable practices and the need for further research in this area.

5. Conclusions

The main aim of this research was to measure the influence of green process innovation, green entrepreneurial orientation, and sustainable strategy on the environmental performance of Indian AgTech firms, which represents a unique context. Data were collected from 294 AgTech firms, and structural equation modeling was applied using Lisrel 8.80. The results found statistical support for all of the hypotheses. The findings show that green process innovation, green entrepreneurial orientation, and sustainable strategy have positive effects on entrepreneurial performance. These findings are aligned with the existent literature [10,23,63].

The research findings in question have practical applications for those in the field of agricultural technology. Specifically, the results of the research can be used by managers of agricultural technology companies to design and implement production methods that are more environmentally friendly and sustainable.

In the context of agribusiness, cleaner production techniques refer to methods of producing food and agricultural products that minimize negative environmental impacts while maximizing economic efficiency. These techniques may include reducing or eliminating the use of harmful chemicals, implementing energy-efficient processes, and recycling or reusing resources. By utilizing the research findings, managers of agricultural technology firms can develop systems that utilize these cleaner production techniques, thereby promoting sustainable agricultural practices and protecting the environment.

It is worth noting that the implementation of cleaner production techniques in agribusiness is not only beneficial for the environment but also for the agricultural industry itself, as it can lead to saving costs, improving reputations, and increasing efficiency. Furthermore, it is also aligned with the global trend of sustainable production and could also help to comply with regulations and standards, which are becoming more stringent.

The limitations of this research provide areas for future study. Firstly, the study looked at the role of green process innovation, and other forms of green innovation might be taken into consideration to broaden this viewpoint (e.g., products, marketing, or business models). Secondly, the study focused on how the antecedents affect environmental performance, and future research can examine managerial, operational, or innovative performance. Thirdly, control variables were not taken into account, and further studies may do so (e.g., firm age, firm size, and presence of external capital). Lastly, it is important to remember when interpreting the findings that the sample only included AgTechs from nations with growing economies where agribusiness is extremely important. Future research may therefore take into account AgTechs from other developing nations that are making sustainable technological transformations. Future studies can look at how a set of environmental management control systems [39] aids in the implementation of proactive sustainability plans and what it means for environmental innovation and performance.

Funding: This research received no external funding.

Data Availability Statement: Data of this Study are available from the Corresponding Author upon the request.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Davis, J.H.; Goldberg, R.A. *A Concept of Agribusiness*; Division of Research Graduate School of Business Administration, Harvard University: Boston, MA, USA, 1957.
2. Cavallo, A.; Ghezzi, A.; Guzman, B.V.R. Driving internationalization through business model innovation: Evidences from an AgTech company. *Multinatl. Bus. Rev.* **2020**, *28*, 201–220. [CrossRef]
3. Mikhailov, A.; Oliveira, C.; Padula, A.D.; Reichert, F.M. Californian innovation ecosystem:emergence of agtechs and the new wave of agriculture. *Innov. Manag. Rev.* **2021**, *18*, 292–307. [CrossRef]
4. Kureski, R.; Moreira, V.R.; Veiga, C.P.D. Agribusiness participation in the economic structure of a Brazilian region: Analysis of GDP and indirect taxes. *Rev. de Econ. E Sociol. Rural* **2020**, *58*, 7517806. [CrossRef]
5. Silajdzic, I.; Kurtagic, S.M.; Vucijak, B. Green entrepreneurship in transition economies: A case study of Bosnia and Herzegovina. *J. Clean. Prod.* **2015**, *88*, 376–384. [CrossRef]
6. Kuckertz, A.; Berger, E.S.; Gaudig, A. Responding to the greatest challenges? Value creation in ecological startups. *J. Clean. Prod.* **2019**, *230*, 1138–1147. [CrossRef]
7. Blank, S.; Dorf, B. *The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company*; K. and S. Ranch Publishers: Pescadero, CA, USA, 2012.
8. Peralta, C.B.L.; Echeveste, M.E.; Martins, V.L.M.; Lermen, F.H. Applying the framework toidentify customer value: A case of sustainable product in agriculture. *J. Clean. Prod.* **2020**, *270*, 122384. [CrossRef]
9. Cai, W.G.; Zhou, X.L. On the drivers of eco-innovation: Empirical evidence from China. *J. Clean. Prod.* **2014**, *79*, 239–248. [CrossRef]
10. Huang, J.W.; Li, Y.H. Green innovation and performance: The view of organizational capability and social reciprocity. *J. Bus. Ethics* **2017**, *145*, 309–324. [CrossRef]
11. Jiang, W.; Chai, H.; Shao, J.; Feng, T. Green entrepreneurial orientation for enhancing firm performance: A dynamic capability perspective. *J. Clean. Prod.* **2018**, *198*, 1311–1323. [CrossRef]
12. Xavier, A.F.; Naveiro, R.M.; Aoussat, A.; Reyes, T. Systematic literature review of ecoinnovation models: Opportunities and recommendations for future research. *J. Clean. Prod.* **2017**, *149*, 1278–1302. [CrossRef]
13. Zhou, Y.; Hong, J.; Zhu, K.; Yang, Y.; Zhao, D. Dynamic capability matters: Uncovering its fundamental role in decision making of environmental innovation. *J. Clean. Prod.* **2018**, *177*, 516–526. [CrossRef]
14. Wong, C.Y.; Wong, C.W.; Boon-itt, S. Effects of green supply chain integration and green innovation on environmental and cost performance. *Int. J. Prod. Res.* **2020**, *58*, 4589–4609. [CrossRef]
15. Guo, Y.; Wang, L.; Chen, Y. Green entrepreneurial orientation and green innovation: The mediating effect of supply chain learning. *SAGE Open* **2020**, *10*, 136. [CrossRef]
16. Ribeiro-Soriano, D.; Pi~neiro-Chousa, J. Innovative strategic relationships amon sustainable start-ups. *Ind. Mark. Manag.* **2021**, *94*, 106–114. [CrossRef]
17. Sher, A.; Mazhar, S.; Zulfiqar, F.; Wang, D.; Li, X. Green entrepreneurial farming: A dream or reality? *J. Clean. Prod.* **2019**, *220*, 1131–1142. [CrossRef]
18. Arnold, M.G.; Hockerts, K. The greening dutchman: Philips' process of green flagging to drive sustainable innovations. *Bus. Strategy Environ.* **2011**, *20*, 394–407. [CrossRef]
19. Shirokova, G.; Bogatyreva, K.; Beliaeva, T.; Puffer, S. Entrepreneurial orientation and firm performance in different environmental settings. *J. Small Bus. Enterp. Dev.* **2016**, *23*, 703–727. [CrossRef]
20. Lumpkin, G.T.; Dess, G.G. Clarifying the entrepreneurial orientation construct and linking it to performance. *Acad. Manag. Rev.* **1996**, *21*, 135–172. [CrossRef]
21. Pratono, A.H.; Darmasetiawan, N.K.; Yudiarso, A.; Jeong, B.G. Achieving sustainable competitive advantage through green entrepreneurial orientation and market orientation. *Bottom Line* **2019**, *32*, 2–15. [CrossRef]

22. Habib, M.A.; Bao, Y.; Ilmudeen, A. The impact of green entrepreneurial orientation, market orientation and green supply chain management practices on sustainable firm performance. *Cogent Bus. Manag.* **2020**, *7*, 1743616. [CrossRef]
23. Chiou, T.Y.; Chan, H.K.; Lettice, F.; Chung, S.H. The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. *Transp. Res. Part E Logist. Transp. Rev.* **2011**, *47*, 822–836. [CrossRef]
24. Muangmee, C.; Dacko-Pikiewicz, Z.; Meekaewkunchorn, N.; Kassakorn, N.; Khalid, B. Green entrepreneurial orientation and green innovation in small and medium-sized enterprises (SMEs). *Soc. Sci.* **2021**, *10*, 136. [CrossRef]
25. Wang, C.H. How organizational green culture influences green performance and competitive advantage: The mediating role of green innovation. *J. Manuf. Technol. Manag.* **2019**, *30*, 666–683. [CrossRef]
26. Torugsa, N.A.; O'Donohue, W.; Hecker, R. Proactive CSR: An empirical analysis of the role of its economic, social and environmental dimensions on the association between capabilities and performance. *J. Bus. Ethics* **2013**, *115*, 383–402. [CrossRef]
27. Wijethilake, C. Proactive sustainability strategy and corporate sustainability performance: The mediating effect of sustainability control systems. *J. Environ. Manag.* **2017**, *196*, 569–582. [CrossRef]
28. Judge, W.Q.; Douglas, T.J. Performance implications of incorporating natural environmental issues into the strategic planning process: An empirical assessment. *J. Manag. Stud.* **1998**, *35*, 241–262. [CrossRef]
29. Sharma, S.; Vredenburg, H. Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities. *Strateg. Manag. J.* **1998**, *19*, 729–753. [CrossRef]
30. Klassen, R.D.; Whybark, D.C. The impact of environmental technologies on manufacturing performance. *Acad. Manag. J.* **1999**, *42*, 599–615. [CrossRef]
31. Wagner, M.; Schaltegger, S. The effect of corporate environmental strategy choice and environmental performance on competitiveness and economic performance:: An empirical study of EU manufacturing. *Eur. Manag. J.* **2004**, *22*, 557–572. [CrossRef]
32. Bansal, P. Evolving sustainably: A longitudinal study of corporate sustainable development. *Strateg. Manag. J.* **2005**, *26*, 197–218. [CrossRef]
33. Lisi, I.E. Translating environmental motivations into performance: The role of environmental performance measurement systems. *Manag. Account. Res.* **2015**, *29*, 27–44. [CrossRef]
34. Yu, C.; Zhang, Z.; Lin, C.; Wu, Y.J. Knowledge creation process and sustainable competitive advantage: The role of technological innovation capabilities. *Sustainability* **2017**, *9*, 2280. [CrossRef]
35. Markard, J.; Raven, R.; Truffer, B. Sustainability transitions: An emerging field of research and its prospects. *Res. Policy* **2012**, *41*, 955–967. [CrossRef]
36. Zhang, D.; Rong, Z.; Ji, Q. Green innovation and firm performance: Evidence from listed companies in China. *Resources Conserv. Recycl.* **2019**, *144*, 48–55. [CrossRef]
37. Wang, K.H.; Umar, M.; Akram, R.; Caglar, E. Is technological innovation making world Greener? An evidence from changing growth story of China. *Technol. Forecast. Soc. Chang.* **2021**, *165*, 120516. [CrossRef]
38. Huang, Y.C.; Wu, Y.C.J. The effects of organizational factors on green new product success. *Manag. Decis.* **2010**, *48*, 1539–1567. [CrossRef]
39. Wolfert, S.; Ge, L.; Verdouw, C.; Bogaardt, M.J. Big data in smart farming—A review. *Agric. Syst.* **2017**, *153*, 69–80. [CrossRef]
40. Wilson, G.A.; Perepelkin, J. Failure learning orientation, entrepreneurial orientation, and financial performance among US biotechnology firms. *J. Small Bus. Manag.* **2020**, *60*, 786–804. [CrossRef]
41. Tang, M.; Walsh, G.; Lerner, D.; Fitza, M.A.; Li, Q. Green innovation, managerial concern and firm performance: An empirical study. *Bus. Strategy Environ.* **2018**, *27*, 39–51. [CrossRef]
42. Ameer, F.; Khan, N.R. Green Entrepreneurial Orientation and Corporate Environmental Performance: A Systematic Literature Review. *Eur. Manag. J.* **2022**, *in press*. Available online: https://www.sciencedirect.com/science/article/abs/pii/S0263237322000597 (accessed on 2 February 2023).
43. Luu, T.T. Green creative behavior in the tourism industry: The role of green entrepreneurial orientation and a dual-mediation mechanism. *J. Sustain. Tour.* **2021**, *29*, 1290–1318. [CrossRef]
44. Hart, S.L. A natural-resource-based view of the firm. *Acad. Manag. Rev.* **1995**, *20*, 986–1014. [CrossRef]
45. Baumgartner, R.J.; Ebner, D. Corporate sustainability strategies: Sustainability profiles and maturity levels. *Sustain. Dev.* **2010**, *18*, 76–89. [CrossRef]
46. Banker, R.D.; Ma, X.; Pomare, C.; Zhang, Y. When doing good for society is good for shareholders: Importance of alignment between strategy and CSR performance. *Rev. Account. Stud.* **2022**. [CrossRef]
47. Rossiter, W.; Smith, D.J. Green innovation and the development of sustainable communities: The case of blueprint regeneration's trent basin development. *Int. J. Entrep. Innov.* **2018**, *19*, 21–32. [CrossRef]
48. Michie, J.; Sheehan, M. Business strategy, human resources, labour market flexibility and competitive advantage. *Int. J. Hum. Resour. Manag.* **2005**, *16*, 445–464. [CrossRef]
49. Chang, H.-T.; Chi, N.-W. Human resource managers' role consistency and HR performance indicators: The moderating effect of interpersonal trust in Taiwan. *Int. J. Hum. Resour. Manag.* **2007**, *18*, 665–683. [CrossRef]
50. Mandip, G. Green HRM: People management commitment to environmental sustainability. *Res. J. Recent Sci.* **2012**, *2277*, 2502.
51. Jones, O. Strategic HRM: The implications for pharmaceutical R&D. *Technovation* **1996**, *16*, 21–32.
52. Armstrong, J.S.; Overton, T.S. Estimating nonresponse bias in mail surveys. *J. Mark. Res.* **1977**, *14*, 396–402. [CrossRef]

53. Podsakoff, P.M.; MacKenzie, S.B.; Lee, J.-Y.; Podsakoff, N.P. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *J. Appl. Psychol.* **2003**, *88*, 879–903. [CrossRef]
54. Aguinis, H.; Ramani, R.S.; Alabduljader, N. What you see is what you get? Enhancing methodological transparency in management research. *Acad. Manag. Ann.* **2018**, *12*, 83–110. [CrossRef]
55. Hair, J.F., Jr.; Risher, J.J.; Sarstedt, M.; Ringle, C.M. When to use and how to report the results of PLS-SEM. *Eur. Bus. Rev.* **2019**, *31*, 2–24. [CrossRef]
56. Jöreskog, K.G.; Sörbom, D. *LISREL 8: Structural Equation Modeling with the SIMPLIS Command Language*; Scientific Software International: Baltimore, MD, USA, 1993.
57. Hair, J.F., Jr.; Hult, G.T.M.; Ringle, C.; Sarstedt, M. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd ed.; Sage: Thousand Oaks, CA, USA, 2017.
58. Cannavale, C.; Nadali, I.Z.; Esempio, A. Entrepreneurial orientation and firm performance in a sanctioned economy–does the CEO play a role? *J. Small Bus. Enterp. Dev.* **2020**, *27*, 1005–1027. [CrossRef]
59. Bauweraerts, J.; Pongelli, C.; Sciascia, S.; Mazzola, P.; Minichilli, A. Transforming entrepreneurial orientation into performance in family SMEs: Are nonfamily CEOs better than family CEOs? *J. Small Bus. Manag.* **2021**, 1–32. [CrossRef]
60. Dabic, M.; Vlacic, B.; Kiessling, T.; Caputo, A.; Pellegrini, M. Serial entrepreneurs: A review of literature and guidance for future research. *J. Small Bus. Manag.* **2021**, 1–36. [CrossRef]
61. Bastini, K.; Getzin, F.; Lachmann, M. The effects of strategic choices and sustainability control systems in the emergence of organizational capabilities for sustainability. *Account. Audit. Account. J.* **2022**, *35*, 1121–1153. [CrossRef]
62. Frare, A.B.; Beuren, I.M. The role of green process innovation translating green entrepreneurial orientation and proactive sustainability strategy into environmental performance. *J. Small Bus. Enterp. Dev.* **2022**, *29*, 789–806. [CrossRef]
63. Testa, F.; Gusmerottia, N.M.; Corsini, F.; Passetti, E.; Iraldo, F. Factors affecting environmental management by small and micro firms: The importance of entrepreneurs' attitudes and environmental investment. *Corp. Soc. Responsib. Environ. Manag.* **2016**, *23*, 373–385. [CrossRef]
64. Muñoz, P.; Cohen, B. Sustainable entrepreneurship research: Taking stock and looking ahead. *Bus. Strategy Environ.* **2018**, *27*, 300–322. [CrossRef]